This is most likely due to differences in input prices (which were not standardized in this analysis), basic loop engineering, and customer location methods. Therefore, it appears that there has not been much, if any, convergence between the models.

Before commencing with our analysis of the current versions of the proxy models, it is important to understand what proxy models do and do not represent. The underlying basis of the proxy models, namely their scorched node approach to building and costing telecommunications networks, must be fully understood. As we have stated previously, such a modeling approach is not likely to accurately reflect the costs of a dynamically efficient actual market participant—whether the participant is an incumbent or an entrant:

> "The idealized statically efficient entrant interpretation does not represent the performance of an actual entrant or incumbent who is dynamically efficient. Actual entrants and incumbents, who are dynamically efficient, will generally deviate from this ideal because of uncertainty, the capital intensive nature of the telecommunications industry, and its rapid rate of technological change. Therefore, if rates were strictly based on the cost levels produced from models adhering to the idealized standard of instantaneous static efficiency, cost recovery problems would be created for both incumbent LECs and actual market entrants."[6]

Because of these limitations, we previously concluded that while proxy models could be developed to adequately reflect relative costs to identify high-cost areas to serve, proxy models are not suited to accurately reflect actual forward-looking cost levels of actual market participants:

> "Proxy models were initially developed to identify high-cost areas for universal service funding purposes and have evolved into multiple-use models. While proxy models may be useful for determining relative cost relationships between high-cost and low-cost areas for purposes of targeting a given size universal service fund, their suitability for determining cost levels for network elements or services, such as access, is limited. This is because the

[6] "Appropriate Standards for Cost Models and Methodologies," p. 9.

information requirements to develop company-specific or geographic-specific costs for network elements or services is much greater than can be developed from the broad, publicly-available data sources used by the proxy models. At the very least, company or area-specific inputs are required to accomplish this task."

"Moreover, the efficient design of actual networks in specific geographic locations is likely to vary from those generated by the broad assumptions contained in the proxy model network designs. Again, this makes it very difficult for general proxy models to adequately capture the true cost characteristics of efficiently-designed actual networks that are needed to establish cost levels." [7]

Section II of this report summarizes the main changes in BCPM3.0 and HM5.0 relative to their predecessors. Section III evaluates the models with respect to the FCC's criteria. Section IV compares results of the current versions of the models and also standardizes inputs to facilitate an "apples-to-apples" assessment of the model platforms. In Section V, we comment on the operation of the current versions of the models. Section VI presents our conclusions.

II. Summary of Model Changes

Both BCPM3.0 and HM5.0 have undergone significant changes since our last evaluation of BCPM1.1 and HM3.1. Below is a summary of those changes.

<u>Changes in BCPM3.0 from Previous Versions of BCPM</u>

According to the BCPM3.0 documentation, the following changes are incorporated into BCPM3.0:[8]

- The model uses housing and business line data at the Census Block (CB) level, overlays microgrids upon CBs and accounts for the actual

[7] Id., p. 11.
[8] "Benchmark Cost Proxy Model Release 3.0 Model Methodology," BellSouth, INDETEC International, Sprint and US WEST, December 11, 1997 ("BCPM3.0 Documentation"), pp. 6-8.

road network to locate customers within a CB. Optimal grid size is based on efficient network design.

- Wire center boundaries are specified by Business Location Research (BLR) to assign customers to the appropriate wire center and local exchange carrier.
- Customers are no longer assumed to be uniformly distributed throughout the CBG.
- The switch module allows for host, remote and stand-alone switches and has separate cost curves for each switch type.
- The transport module designs SONET rings for transport.

The following features are the same as previous versions of BCPM:

- Default cost of capital.
- Default expenses (although can be stated on per-line or ratio to investment).
- Default structure sharing.

<u>Changes in HM5.0 from to Previous Versions of HM</u>

According to the HM5.0 manual, the following changes are reflected in HM5.0:[9]

- Customer locations are geocoded. Clusters of customers that may be served efficiently together are identified.
- Outside plant is suited to particular local conditions.
- Explicit specification of host, remote and stand-alone switches.
- Interoffice SONET transport rings.
- Expenses can be allocated based on lines or investment.

The following features are the same as previous versions of HM:

- Default switch investment curve.
- Default structure sharing.
- Default capital cost.
- Default variable overhead factor.

While there have been significant changes made to both models, there are still some areas where the models have retained some of the features of previous versions. Many of these unchanged features fall within the area of input values--

[9] "Hatfield Model Release 5.0 Model Description," HAI Consulting, December 11, 1997 ("HM5.0 Documentation") , p. 4.

such as cost of capital, expenses, and structure sharing percentages—and, therefore, are outside the scope of the current model platform analysis.[10] However, one such feature that has been retained by HM5.0 and can be categorized as a platform issue is switching. HM5.0 still relies on the same questionable switching curve found in previous versions of the Hatfield Model. From HM5.0 documentation:

> "In default mode, the model assumes a blended configuration of switch technologies. The switching cost curves for this blended configuration were developed using typical per-line price paid by BOCs, GTE and other independents as reported in the Northern Business Information (NBI) publication, 'U.S. Central Office Equipment Market: 1995 Database.'"[11]

Even though the HM sponsors call their switch curve a "blended configuration of switch technologies" and assert that HM5.0 incorporates an "explicit specification of host, remote and stand-alone switches,"[12] the HM5.0's default switching module is essentially unchanged from the deficient switching module found in previous versions of HM.[13] This is despite the FCC's recommendation that individual switches be identified as host, remote, or stand-alone, and that there be separate cost curves for host, remote and stand-alone switches.[14]

III. Evaluation of Proxy Models with Respect to FCC Criteria

---

[10] In the BCPM3.0 Documentation, developers of the BCPM acknowledge that they have spent almost all of their efforts on platform development and refinement, leaving inputs unchanged from BCPM1.1.

[11] HM5.0 Documentation, p. 52.

[12] HM5.0 Documentation, p. 4.

[13] For example, see "Joint Reply Comments of BellSouth Corporation, BellSouth Telecommunications, Inc., US WEST, Inc., and Sprint Local Telephone Companies to Further Notice of Proposed Rulemaking," CC Docket No. 96-45 and 97-160, August 18, 1997 ("Joint Reply Comments"); and "Comments of GTE Service Corporation," CC Docket No. 96-45 and 97-160, August 8, 1997.

[14] "Guidance to Proponents of Cost Models in Universal Service Proceeding: Switching, Interoffice Trunking, Signaling, and Local Tandem Investment," Public Notice, DA 97-1912, September 3, 1997.

Paragraph 250 of the Universal Service Order contains 10 criteria prescribed by the FCC that must be met by any cost model or methodology to ensure the appropriate calculation of universal service support.[15] In this section, we evaluate each of the proxy models with respect to these criteria. Each criterion is listed separately below, immediately followed by our analysis of the proxy models with respect to that criterion. Given the incomplete nature of the HCPM, the focus of this evaluation will be on BCPM3.0 and HM5.0. Comments on HCPM will be included where appropriate.

A. Evaluation of Proxy Models

1. *The technology assumed in the cost study or model must be the least-cost, most efficient, and reasonable technology for providing the supporting services that is currently being deployed. A model, however, must include the ILECs' wire centers as the center of the loop network and the outside plant should terminate at ILECs' current wire centers. The loop design incorporated into a forward-looking economic cost study or model should not impede the provision of advanced services. For example, loading coils should not be used because they impede the provision of advanced services. We note that the use of loading coils is inconsistent with the Rural Utilities Services guidelines for network deployment by its borrowers. Wire center line counts should equal actual ILEC wire center line counts, and the study's or model's average loop length should reflect the incumbent carrier's actual average loop length.*

There are actually four requirements contained in Criterion 1. We examine them separately below.

> *1a. "The technology assumed in the cost study or model must be the least-cost, most-efficient, and reasonable technology for providing the supported services that is currently being deployed."*

[15] Supported services include: single-party service; voice grade access to the public switched network; Dual Tone Multifrequency (DTMF) signaling; access to emergency services; access to operator services; access to interexchange services; access to directory assistance; and toll limitation services for qualifying low-income consumers. See Universal Service Order, para 56.

Subject to the qualification that the forward-looking costs of a hypothetical scorched node network will not likely reflect the cost of a dynamically efficient actual market participant, both the BCPM3.0 and HM5.0 partially satisfy this criterion. However, because of the general nature of proxy models and their primary reliance on publicly available data, none of the models fully integrates the engineering requirements with an economic assessment of the least-cost technology required to satisfy the engineering requirements. What is required is, first, an assessment of the minimal engineering requirements needed to provide the defined set of services. The services include not only supported services, but taking Criteria 1 and 6 together, also include advanced services, multi-line business services, special access, private lines, and multiple residential lines. Once the engineering parameters to provide these services are specified, an economic analysis of the least-cost way of provisioning these services over the lifetime of the requisite investments is required.

For example, in its default mode, HM5.0 does not optimize its network over the services outlined by the FCC criteria and, therefore, does not perform the appropriate least-cost network calculations. Although the network engineered by BCPM3.0 models high-speed circuits, BCPM3.0 does not appear to fully analyze the least-cost approach of constructing the network over the lifecycle of the required investments. It should also be noted that, at this point in its development, HCPM is not capable of modeling the least-cost life cycle costs. This is because HCPM only models investments and does not have an expense module. Thus, HCPM cannot account for expenses over the lifetime of investments.

Both BCPM3.0 and HM5.0 employ feeder steering to guide main feeder routes toward population centers. While neither model accounts for natural obstacles, such as lakes or mountains, in steering feeder routes to population centers, this technique will tend toward more efficient use of feeder cable. Of the two models, HM5.0 is the most efficient in placing sub-feeder cable. HM5.0 places sub-feeder cables perpendicular to main feeder routes. BCPM3.0, on the other hand, will route sub-feeder cable in one of the cardinal directions to reach a serving area. This can result in more sub-feeder cable being placed by BCPM3.0.

HM5.0 does not adequately account for the least-cost, most-efficient switching technology. As noted above, HM5.0 still relies on the same switching module as previous versions of the Hatfield Model. This switching module does not adequately account for identification of host, remote and stand-alone switches per the FCC's recommendation.[16] This also has implications for HM5.0's transport costs. Since HM5.0 does not adequately identify host, remote and stand-alone locations, it cannot place the appropriate quantity and type of transport facilities between switch locations. For example, HM5.0 cannot adequately account for host-remote links in its transport facilities, nor the efficient quantity and routing of transport facilities between switching entities. In fact, as GTE has pointed out, the hypothetical transport network constructed by the Hatfield Model is inconsistent with forward-looking switch designs and resulting route designs.[17]

BCPM3.0 does allow for separate cost curves for host, remote and stand-alone switches and identifies their locations. This is an improvement over previous

[16] Public Notice, DA 97-1912, September 3, 1997.
[17] GTE Comments, August 8, 1997.

versions of BCPM and over HM5.0. However, because BCPM3.0 relies on the placement of switch types found in Bellcore's LERG, the decision as to whether to deploy host, remote or stand-alone switches is partially an embedded decision.[18]

> *1b. "A model, however, must include the ILECs' wire centers as the center of the loop network and the outside plant should terminate at ILECs' current wire centers. "*

Both models design their networks from scratch keeping wire center locations fixed—i.e., a "scorched node" approach. Neither model takes a scorched-earth approach to network design (where the network would be designed from scratch with wire centers being located to minimize costs).

> *1c. "The loop design incorporated into a forward-looking economic cost study or model should not impede the provision of advanced services. For example, loading coils should not be used because they impede the provision of advanced services. We note that the use of loading coils is inconsistent with the Rural Utilities Services guidelines for network deployment by its borrowers."*

The network designed by BCPM3.0 is capable of providing advanced services. In fact, the proportion of high-speed circuits modeled by BCPM3.0 varies by the number of lines per grid, with the proportion of high-speed circuits increasing as the number of lines per grid increases. Presumably, this reflects differences in business concentration. However, in its default mode, HM5.0 does not model high-speed circuits and, therefore, is not capable of providing advanced services. Thus, HM5.0 is not in compliance with the FCC requirements on this point (nor is it in

[18]The BCPM3.0 sponsors note that, because the proxy models rely on publicly-available information, it is not possible to perform a truly forward-looking optimization of switch type placements. Such a decision would require use of confidential vendor and LEC data. See Joint Comments, CC Docket 96-45 and 97-160, August 8, 1997, Attachment 1, pp. 1-2.

compliance with Criterion 6). While the user can account for high-speed circuits in HM5.0, the proportion cannot be altered by the number of lines per grid as in BCPM3.0.

An indication of the differences in engineering required to provide various services is found in the different approaches to choosing cables gauges between the two models. HM5.0 makes the decision to use 24-gauge versus 26-gauge based solely on the number of pairs in the cable. BCPM3.0 accounts for line resistance in the decision to use 24-gauge versus 26-gauge cable.

> *1d. "Wire center line counts should equal actual ILEC wire center line counts, and the study's or model's average loop length should reflect the incumbent carrier's actual average loop length."*

Both models use wire center boundaries provided by Business Location Research, Inc. (BLR). Previous versions of each model had assigned Census Block Groups (CBGs) to the nearest serving wire center. As a result, many customers were incorrectly assigned to the wrong wire centers. Both models now identify customer locations with a much finer resolution, leading to much more accurate wire center assignments.

To validate the models according to this criterion, we would need to know LEC line counts by wire center in order to have a value to compare the models' output to. To our knowledge, such data have not been made publicly available. Unless each LEC has performed a study to calculate average loop lengths, these data are not readily available either. The best most companies could do is estimate route miles or conductor miles. Route and conductor mile statistics do not represent loop lengths because of different fill characteristics.

Line count controls for both BCPM3.0 and HM5.0 are at high levels of aggregation. BCPM3.0 controls lines to state totals and HM5.0 controls lines to company totals. In both instances, line totals at lower levels of aggregation (such as wire center or CBG) are estimates based on some allocation procedure.

BCPM3.0 still uses a residential line multiplier that can be multiplied by the number of households in each "ultimate grid" to estimate the number of lines. The residential line multiplier is calculated by dividing the statewide number of residential access lines by the statewide number of households. For statewide runs, BCPM3.0 results will be more accurate because the totals are controlled to NECA reported line counts. Line counts at the wire center level are not controlled to actual reported lines.

HM5.0 controls to actual line counts reported by each company. The model's developers estimated company line counts where reported line counts were unavailable. This method will only result in accurate line counts at the company level for only those companies whose line counts have not been estimated. Similar to BCPM3.0, HM5.0 can only provide estimates of line counts at the wire center level.

BCPM3.0 clearly presents its calculated average loop lengths on its reports. HM5.0, on the other hand, leaves the calculation of average loop lengths up to the user. Average feeder and distribution lengths are available in the workfile, but only for each cluster. The user would need to construct a weighted average loop length over all of the clusters in order to estimate loop lengths at the wire center level. Since HM5.0 still does not summarize results at the state level, constructing a statewide weighted average loop length would entail a great deal of spreadsheet programming.

2. *Any network function or element, such as loop, switching, transport, or signaling necessary to produce supported services must have an associated cost.*

Both HM5.0 and BCPM3.0 produce costs for all network elements. However, this is not to say that the costs produced by the models are appropriate or accurate. For example, as we discussed above, in its default mode, the HM5.0 network does not include any switched or special service high-speed circuits, such as DS-1 or DS-3. As a result, HM5.0 fails to account for any economies of scope that result from including these advanced services in the network design. We also noted that HM5.0's switching and transport costs do not reflect the forward-looking costs that would be incurred by an actual market participant.

In previous versions of the BCPM, the developers made no effort to explicitly cost out transport or signaling elements. Instead, they assumed that transport and signaling functions were 3 percent of switching investment. However, a major improvement with BCPM3.0 is the inclusion of a module to explicitly cost out transport—the Transport Cost Proxy Model (TCPM). BCPM3.0 also has a provision for a signaling module. At the current time, BCPM3.0 signaling costs are exogenously determined by the Signaling Cost Proxy Model (SCPM) that was run on US WEST territory. The signaling costs obtained from the SCPM run were then placed in BCPM3.0 as a fixed value.

3. *Only long-run forward-looking economic cost may be included. The long-run period used must be a period long enough that all costs may be treated as variable and avoidable. The costs must not be the embedded cost of the facilities, functions, or elements. The study or model, however, must be based upon an examination of the current cost of purchasing facilities and equipment, such as switches and digital loop carriers (rather than list prices).*

By design, neither BCPM3.0 nor HM5.0 relies on embedded "facilities, functions, or elements" but rather take a scorched node approach to network design. As we discussed in Section I, however, the scorched node approach to modeling a hypothetical market participant is not likely to accurately reflect the costs of a dynamically efficient actual market participant—whether the participant is an incumbent or an entrant.

The models are not always consistent or definitive as to what constitutes forward-looking, least-cost practices. This may be due to the lack of an integrated analysis of the engineering parameters required to provide the defined set of services and the economic evaluation of the least–cost method of providing the services. This is a limitation of proxy models, which necessarily rely on general rules of thumb and publicly available data. Proxy models simply cannot account for all the factors specific to a decision and do not have access to all the information that are used to determine forward-looking, least-cost decisions by actual market participants.[19]

Both models purport to assign forward-looking costs to modeled elements. This criterion requires that input prices and other cost factors be based on costs

[19] For instance, as noted above, the switching costs estimated by both models are not likely to be truly forward-looking. BCPM3.0 is more advanced in this respect. However, because of the need to use publicly available data, BCPM3.0 relies on existing host, remote and stand-alone designations, which likely vary from forward-looking, least-cost determinations of the mix of switch types actually performed by companies.

currently faced by incumbent LECs. Although it is not the focus of this phase of the FCC's evaluation, our analysis of the current versions of the models indicates that validation of input values is still a significant effort to be undertaken. In some cases, the assumptions that link current costs of facilities and equipment to the model parameters are clearly suspect. An example is the $20,000 cost per transaction/second (TPS) for SCP hardware in HM 5.0. This figure is derived from a 1990 cost survey, which priced SCP hardware at $30,000/TPS. The HM developers' judgment is that 1997 forward-looking cost is 2/3 of the 1990 figure, but comparable computer hardware is actually much cheaper in 1997.[20]

Although this input has little impact on per-line investment, it is possible that there are other significantly misstated input prices with larger investment and cost consequences, particularly since many of the models' cost inputs are not directly comparable to one another. For example, BCPM3.0 and HM5.0 account for plant installation costs in different ways, making it difficult to compare or judge the reasonableness of these costs in the two models. For the most part, HM5.0 provides more extensive documentation of default cost parameters. However, by their own admission, developers of the BCPM have recently devoted most of their attention to model platform issues and have left inputs basically unchanged since version 1.1 of the BCPM.

[20] We have found a few more recent price points for SCP-type computer hardware that suggests the $20,000/TPS figure is overstated by a factor of at least 3 or 4. The June 1994 issue of an on-line newsletter called IRIS Online reported a cost of $5,434/TPS for a Silicon Graphics Challenge server. A Silicon Graphics press release from 1997 reported that one of their Origin 2000 systems (the successor to the Challenge line) had set a speed record by reaching 25,000 transactions per minute at a cost of $8,340/TPS. A reasonable assumption is that less speedy systems would cost less than $8,340/TPS.

HM5.0 expenses are based in part on ARMIS data, which the HM documentation describes as reflecting "embedded" costs. The HM logic converts these embedded expenses into forward-looking expenses by application of a forward-looking expense factor, which is arbitrarily set at 50 percent of embedded expenses. There is no foundation for this factor. The BCPM3.0 approach, in which both fixed per-line amounts and ratios to investment can be specified independently for several expense categories, is more flexible.

4. *The rate of return must be either the authorized federal rate of return on interstate services, currently 11.25 percent, or the state's prescribed rate of return for intrastate services. We conclude that the current federal rate of return is a reasonable rate of return by which to determine forward looking costs.*

Both models allow any desired rate of return to be specified by the user. However, neither model's default rate of return equals 11.25%. Both models continue to use the default rate of returns found in the previous versions of the models: 10.01% for HM5.0 and 11.39% for BCPM3.0. BCPM3.0 is supplied with a pre-set "FCC scenario" that implements the 11.25% rate of return.

5. *Economic lives and future net salvage percentages used in calculating depreciation expense should be within the FCC-authorized range. We agree with those commenters that argue that currently authorized lives should be used because those assets used to provide universal service in rural, insular, and high cost areas are unlikely to face serious competitive threat in the near term.*

Both models permit economic lives and future net salvage percentages to be independently specified by the user. The ability to independently specify economic lives and future net salvage percentages is new to the Hatfield Model since release 3.1. The HM5.0 default lives mostly fall within the FCC-authorized range. BCPM3.0

default lives are significantly shorter than the lower bound of the FCC-authorized range for several key accounts—in particular, aerial, underground, and buried cable. However, BCPM3.0's "FCC scenario" provides a set of economic lives and future net salvage percentages consistent with FCC-authorized ranges.

6. *The cost study or model must estimate the cost of providing service for all businesses and households within a geographic region. This includes the provision of multi-line business services, special access, private lines, and multiple residential lines.*

BCPM3.0 accounts for all loops. The residential line multiplier table provides the ratio of residential lines to households for each state. The use of this ratio accounts for both single and multiple line residences. Ratios greater than one imply that, overall, there are more telephone lines than households. There is also a corresponding business line multiplier table to account for single and multi-line business lines. Additionally, the model accounts for private lines by assuming they vary by grid, depending on the number of business switched access lines in each grid. The table accounts for DS-0 (voice grade), and switched and special DS-1s (1.544 MBps).

As noted above, BCPM controls its estimates to the state level. Therefore, the use of the residential and business line multipliers provides an accurate number of loops at the statewide level. However, at sub-state (company, wire-center, CBG, CB) levels, the estimated line counts can vary from actual line counts.

HM5.0 accounts for the number of switched access lines by controlling to the reported number of lines by company. The sources used for line counts in HM5.0

range from 1993 to 1997.[21] It is unclear if the older line counts have been adjusted to account for growth in access lines since the reports were published. Furthermore, HM5.0 does not estimate the number of higher speed special service loops (DS-1 and up) in its default configuration.[22]

While both BCPM3.0 and HM5.0 include special access line counts, neither model appears to properly account for them. For example, at the main distribution frame, a voice-grade special may be cross connected to another loop that terminates in the same serving area, or it may be multiplexed and added to a transport system heading out to another end-office or possibly an inter-exchange carrier. The former scenario describes a situation in which one special service loop needs to be treated as if it was two loops. The latter scenario should be treated as one loop and one special service transport circuit.

As a percentage of the total number of switched access lines, the number of special service loops is quite small. Therefore, the costs of collecting adequate data may outweigh any benefit from having better estimates of the number of access lines. Each of the model developers should, however, address how they are treating the special service line counts.

7. *A reasonable allocation of joint and common costs should be assigned to the cost of supported services. This allocation will ensure that the forward-looking*

---

[21] The sources for line counts are found on page 20 of the Hatfield Model description. They are: ARMIS 43-08, (10/01/97); ARMIS 43-01, (10/01/97); NECA USF loops filing, 1996; RUS report, 1995; 1993 USF Data Request; and ARMIS-based line factors.

[22] The number of DS-1's, as a percent of total lines, can be set by the user in HM5.0. However, this percent does not vary by the number of lines per grid, as it does in BCPM3.0. Given the number of higher speed lines is likely to be relatively greater in higher density categories with greater concentrations of businesses, this is a deficiency of HM5.0.

economic cost does not include an unreasonable share of the joint and common costs for non-supported services.

Both models include calculations that allocate joint and common costs to supported services. However, such allocations are inherently arbitrary and there is no economic basis on which to judge whether any allocation is "reasonable." Such costs may be specified in BCPM3.0 as per-line amounts or as percentages of investment. HM5.0 support and overhead allocations may now be allocated by lines or by direct expenses using user-adjustable factors. HM5.0's corporate (variable) overhead factor is 10.4%; the same as in HM 3.1.

8. *The cost study or model and all underlying data, formulae, computations, and software associated with the model should be available to all interested parties for review and comment. All underlying data should be verifiable, engineering assumptions reasonable, and outputs plausible.*

Both developers have supplied versions of the models to all interested parties. Not all of the underlying data is verifiable, however. Both models rely on a substantial amount of exogenous processing. The primary example of this is the customer location functions of both models. The input to HM5.0 is a database of records where each record represents the input data for one cluster. The input to BCPM3.0 is a database where each record represents the input data for one ultimate grid. In each model, the processing of the original data (geocoded addresses and Census Block data) have already been performed and the results rolled up into the model input files.

For BCPM3.0 the assignment of Census Block household detail to the grids could be made endogenous to the model. However, processing time would be significantly increased. At the very least, the model uses Census Block level detail that can be externally validated by interested parties. This is not the case with HM5.0.

Users of HM5.0 have to assume that the addresses have been accurately geocoded. However, this assumption is tenuous, at best. When the BCPM developers tried to repeat the process used by the Hatfield Model's developers, they reported that they could accurately geocode only 56 percent of addresses.[23] The Hatfield Model developers dispute this, countering that the Metromail database contains over 90 percent of all residential addresses in the United States.[24] However, regardless of the percentage of addresses that have been geocoded, the accuracy of the addresses that have been geocoded remains an issue.

In addition, the introduction to HM5.0's documentation shows the high licensing costs associated with using Metromail as a source for geocoded addresses. As a result, we do not believe that HM5.0 satisfies the FCC's Criterion number 8. Without access to the raw household locations, HM5.0's assumptions are not verifiable. Access to household locations would enable one to test whether HM5.0's assumptions are accurate and whether BCPM3.0 customer location

[23] "Submission of BCPM3 Model by BellSouth Corporation, BellSouth Telecommunications, Inc. US WEST, Inc., and Sprint Local Telephone Companies," CC Dockets 96-45 and 97-160, December 11, 1997, pp. 6-8, and Attachment 4. The BCPM sponsors used satellite photograph analysis to plot the locations of housing units in several wire center serving areas. They also plotted the geocoded addresses from Metromail and GDT data. The charts produced by the BCPM sponsors clearly show that the Hatfield Model is only capable of accurately geocoding urban customer locations. By simply assuming that the addresses that cannot be geocoded are located along the perimeter of the Census Block, the Hatfield Model will be least accurate in high-cost rural areas--the areas that universal service funds are meant to support.

[24] Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, Secretary, Federal Communications Commission, December 23, 1997.

sources and algorithms produce similar results. This is a key issue that has obvious impacts on the network design of the models.

9. *The cost study or model should include the capability to examine and modify the critical assumptions and engineering principles. These assumptions and principles include, but are not limited to, the cost of capital, depreciation rates, fill factors, input costs, overhead adjustments, retail costs, structure sharing percentages, fiber-copper cross-over points, and terrain factors.*

Both BCPM3.0 and HM5.0 satisfy this criterion with respect to the assumptions and principles listed in the statement of the criterion. If anything, the developers of the models have provided an oversupply of user-adjustable parameters. This surfeit of user-adjustable parameters makes it possible to dramatically alter model results, but at the same time makes it virtually impossible to determine whether the models behave reasonably for all admissible parameterizations. The latest versions of BCPM and HM are, arguably, out of compliance with this criterion insofar as it is not possible to modify the assumptions and principles underlying the models' customer location algorithms.[25] In contrast, HCPM has partially fulfils this criterion with the provision of the source code for its customer location module.[26]

The abandonment of CBG-level customer location or serving area models has been carried out for the purpose of more realistic outside plant engineering, and thus can be said to play a critical role in determining model performance. Therefore, it is crucial that a complete examination of customer location algorithms and all data inputs be facilitated for all models.

[25] See discussion under Criterion 8 above.
[26] However, the data to run HCPM's customer location module do not appear to be available.

10. *The cost study or model must deaverage support calculations to the wire center serving area level at least, and, if feasible, to even smaller areas such as a Census Block Group, Census Block, or grid cell. We agree with the Joint Board's recommendation that support areas should be smaller than the carrier's service area in order to target efficiently universal service support.*

Both HM5.0 and BCPM3.0 will produce support calculation at the wire center level. Both models are also capable of producing results at the Census Block Group level. BCPM3.0 is capable of producing results at even finer levels of detail. HM5.0 will only produce results down to the Census Block Group level.

B. Summary - Evaluation of Proxy Models with respect to FCC's 10 Criteria

Our analysis has focused primarily on the BCPM3.0 and HM5.0 platforms. Model inputs will be examined in subsequent FCC proceedings and, thus, were not a major areh a of analysis in the current report. Because of the incomplete status of HCPM, it was not possible to evaluate the FCC Staff's model with respect to the FCC's 10 criteria. The incomplete nature of the HCPM leads to the obvious conclusion that the model does not meet the FCC's 10 criteria at this time.

Both BCPM3.0 and HM5.0 represent improvements over previous versions of the respective proxy models, benefiting from the extensive model evaluation and comment rounds that have taken place. However, at this point in time, neither model fully satisfies the FCC's 10 criteria. In terms of model platforms, BCPM3.0 appears to be more consistent with the FCC's criteria at this point in time.

A key area that remains unresolved is customer location. Both BCPM3.0 and HM5.0 have improved their customer location algorithms from previous versions of the models. However, because both BCPM3.0 and HM5.0 do a substantial amount of exogenous processing and not all customer location data is readily verifiable, the accuracy of each model's customer location modules is difficult to assess at this time. In this respect the HCPM has an advantage because all of the source code for its customer location module are available for inspection. Complete access to customer location data and algorithms is necessary to determine the accuracy of HM5.0's geocoding and customer location assumptions, and BCPM3.0's customer location sources and algorithms.

Finally, it must be kept in mind that proxy models are not likely to accurately estimate the forward-looking cost levels of an efficient actual market participant. First, as we noted in Section I, the scorched node approach used by the proxy models produces the costs of a hypothetical market participant and is not likely to accurately reflect the forward-looking costs of an actual market participant. Second, given this qualification, proxy models are inherently limited in their ability to determine optimal solutions because of their general nature and their reliance on publicly available data. This is a limitation of all proxy models and not a shortfall of any particular model.

IV. Comparison of BCPM3.0 and HM5.0 Model Results

In this section, we compare results of the latest versions of BCPM3.0 and HM5.0 for the states that were both available for both models at the time of our analysis: Florida, Georgia, Maryland, Missouri, and Montana. First, we compare household and line counts for the two models.[27] Next, we compare annual cost and

[27] Limitations of HM5.0 required us to compile individual company results into statewide totals.

investment results for the models run with their default settings. Finally, we standardize key input values and compare annual cost and investment results.

A. Household and Line Counts

Table 1 compares household counts between BCPM3.0 and HM5.0. For all five states analyzed HM5.0 has greater household counts, ranging from 3 percent greater in Georgia and Montana, to 15 percent greater in Florida. BCPM3.0 still uses 1995 Census estimate of household counts, while HM5.0 uses estimates compiled from the Metromail database and 1996 Claritas CBG-level estimates of households with telephones.[28]

Table 1
Household Counts – BCPM3.0 and HM5.0

	Florida	Georgia	Maryland	Missouri	Montana	Avg	Total
BCPM3.0	5,616,786	2,605,411	1,838,791	2,025,368	326,093	2,482,490	12,412,449
HM5.0	6,461,662	2,693,474	1,931,304	2,192,469	335,268	2,722,836	13,614,178
HM5.0/ BCPM3.0	15%	3%	5%	8%	3%	10%	10%

Table 2 compares total lines per household. In general, the overall line count for each state should be accurate for BCPM3.0, since it controls to statewide totals. On the other hand, HM5.0 controls to company totals, with a variety of sources ranging from 1993 to 1997 used to obtain company line counts. BCPM3.0 has greater total lines per household counts for Florida and Maryland, while HM5.0 total lines per household are greater for Georgia, Missouri, and Montana.

[28] See BCPM3.0 Documentation, p. 24, and HM5.0 Documentation, pp. 21-22.

Table 2
Total Lines Per Household – BCPM3.0 and HM5.0

	Florida	Georgia	Maryland	Missouri	Montana	Avg
BCPM3.0	1.75	1.69	1.85	1.55	1.42	1.71
HM5.0	1.62	1.80	1.83	1.71	1.57	1.70
HM5.0/BCPM3.0	-7%	7%	-1%	10%	10%	-1%

Each model presents line counts for a variety of categories: residential, single-line business, multi-line business, public lines and non-switched lines. In Table 3, we compare BCPM3.0 and HM5.0 residential lines per household. For all states, except Montana, HM5.0 has lower residential lines per household.

Table 3
Residential Lines Per Household – BCPM3.0 and HM5.0

	Florida	Georgia	Maryland	Missouri	Montana	Avg
BCPM3.0	1.21	1.11	1.15	1.09	1.06	1.16
HM5.0	1.08	1.10	1.12	1.02	1.08	1.08
HM5.0/BCPM3.0	-11%	-1%	-3%	-6%	2%	-7%

B. Comparison of Default Model Results

Table 4 compares the average monthly cost per line for the five states and also presents a weighted average (weighted by the states' number of lines) monthly cost per line across the five states. As with previous versions of the models, HM5.0 monthly costs per line are significantly lower than BCPM3.0's monthly costs. On average, HM5.0's monthly costs per line are 43 percent lower. Given the current focus on platform development, input values for both models have remained largely unchanged from previous versions of the models. Therefore, the wide gap between model results is consistent with differences in the results for previous versions of the models.

Table 4
Average Monthly Cost Per Line – BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	$30.78	$38.42	$28.49	$46.17	$111.82	$36.04
HM5.0	$16.26	$22.22	$16.35	$27.78	$68.87	$20.58
HM5.0/BCPM3.0	-47%	-42%	-43%	-40%	-38%	-43%

Monthly (and annual) costs are comprised of two basic components: capital costs, consisting of a return on investment, depreciation and taxes; and expenses, consisting of operating expenses and an allocation of joint and common costs. Table 5 compares BCPM3.0 and HM5.0 monthly capital costs per line and Table 6 compares monthly expenses per line between the two models

Table 5
Average Monthly Capital Costs Per Line – BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	$19.44	$27.08	$17.15	$34.83	$100.48	$24.70
HM5.0	$9.33	$13.75	$8.78	$19.22	$49.93	$12.70
HM5.0/BCPM3.0	-52%	-49%	-49%	-45%	-50%	-49%

Table 6
Average Monthly Operating Expenses Per Line – BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	$11.34	$11.34	$11.34	$11.34	$11.34	$11.34
HM5.0	$6.93	$8.48	$7.57	$8.56	$18.94	$7.89
HM5.0/BCPM3.0	-39%	-25%	-33%	-24%	67%	-30%

From Tables 5 and 6, it can be seen that HM5.0's monthly capital costs are an average of 49 percent lower than BCPM3.0's, and HM5.0's monthly expenses are an average of 30 percent lower. The notable exception is Montana, where HM5.0's expenses are 67 percent greater. Again, given the significant differences in the default input values between the two models on items such as rate of return, depreciation rates and expense loadings, these results are not unexpected.

Because the monthly results are generated from a number of key input values that have maintained their divergence from previous versions of the two models, a better comparison of the BCPM3.0 and HM5.0 model platforms is to examine investment per line for the two models. Table 7 compares total investment per line for BCPM3.0 and HM5.0. On average, HM5.0 investment per line is 43 percent lower across the five states, ranging from 40 percent less in Maryland to 50 percent less in Montana.

Table 7
Total Investment Per Line – BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	$1,248	$1,730	$1,099	$2,238	$6,573	$1,587
HM5.0	$685	$984	$659	$1297	$3,270	$902
HM5.0/BCPM3.0	-45%	-43%	-40%	-42%	-50%	-43%

Tables 8, 9 and 10 decompose total investment per line into loop investment per line, switch investment per line, and other investment per line. Other investment consists of transport, signaling, operator systems, and public telephones.